THE SIR WILLIAM MACLEAY MEMORIAL LECTURE 1982

Ecological Values of the Tropical Rainforest Resource

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'If we knew enough no choice would be trivial, and it is our duty to acquire the knowledge which will enable us to moralize our everyday actions, both by the study of available statistics and by encouraging statistical inquiry elsewhere' (Haldane, 1928).

In medieval times Wisdom was separated into Metaphysics, Morals, and Natural Philosophy which was equivalent to natural science. In the seventeenth century, Newton along with Galileo and Descartes established the prestige and paramountcy of mathematics and physics, and the domination of scientific thinking was well under way. The term 'natural philosophy' became restricted to the exact physical sciences, which were joined by chemistry at the beginning of the 19th century. It remained for Playfair in 1812 to identify Natural History simply as a descriptive and non-experimental science that dealt with vegetable, animal, and mineral objects (Pantin, 1968). Much later, natural history became known as the biological and earth sciences, parts of which became increasingly quantitative, and involved with finer grades of structures and molecular events. In this hierarchical re-arrangement of the sciences, which emphasized precision and experimentation, the so-called descriptive biological sciences stayed at the bottom.

Thus within a century or two of western scientific progress, biology and the study of organism-environment relationships that was to become known as ecology lost their early links with morals and metaphysics, became 'poor relations' of the exact sciences, and were obliged to renounce intrinsic human values in the promotion of objective scientific knowledge.

It is relevant that William Macleay, that great Australian naturalist whose memory we celebrate tonight, identified the Linnean Society of New South Wales, when it was founded just over a century ago, as a 'society of natural history' that he hoped would succeed. It was founded not only 'to promote knowledge', but also 'for the progress of this community, and for the welfare of humanity'. Even then, it seems, the extraordinarily broad interests of early naturalists such as Macleay enabled them to foreshadow the necessary integration of the social and natural sciences — an integration that only now, in international projects such as the Man and the Biosphere programme, is being hesitantly and not too effectively approached.

While admiring what Sir Otto Frankel (1970) called Sir William Macleay's 'remarkable prescience', we may wonder what Sir William would have thought about

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the future losses to human welfare when biological and physical sciences became so rigidly separated, when science became so thoroughly insulated from ethics, and when there was nothing left but utter disdain for metaphysics.

It is more helpful for the biologist today, who retains something of his natural history heritage, to understand the fundamental contrast and separation as not between biological and physical sciences but, as Pantin (1968) put it, 'between unrestricted and restricted sciences'. Thus the ecologist who is obliged to follow the analysis of problems into many other sciences, and even non-sciences, generally must rely on 'natural experiments'; and to gain a broad and integrative view must sacrifice exactness.

Yet ecological observation is not mere description, because perception depends on experience, training, and current concepts. It is hard to accept that observations can be strictly neutral when research directions are selected beforehand, priorities are set by economic standards, and the presentation and interpretation of data are coloured by the requirements of a particular development. In other words, it may not always be possible to separate questions of fact from questions of value. If we are honest about it, I suggest that we all can find some favourite examples.

It has become clear to me that decisions about the use and management of natural resources are unavoidably influenced by value judgements. Questions of fact and questions of value become inseparable in the broad issues of 'ecological problems', as distinct from narrowly-circumscribed technical 'problems in ecology' (Passmore, 1974; Ashby, 1978). The ecologist as an unrestricted scientist is therefore continually implicated with the 'is' of fact, and the 'ought' of valuation that is not intrinsic to his study and rests on an ethical system of some kind.

I wonder what Macleay would have done, had he, with his broad humanist and what we may call his wide ecological interests, been confronted as we are now by this thorny path to applied ecology, to the resolution of choices impelled by knowledge of ecological consequences, and to dawning insights about how certain resources have more values than utilitarian.

In this lecture I shall try to identify some ecological values from a knowledge of rainforests. It seems that understanding how valuable a resource really is must await the accumulation of enough facts and experience: then crystallization occurs to reveal unsuspected facets. First of all I give an international perspective to ecological problems encountered in Australian tropical and subtropical rainforests. Then I briefly examine the Australian forests: their history and interactions with other vegetation and with man, which in turn provide a basis of comparison with rainforests of our northern neighbours. Finally I return to the question of values — ecological and beyond — that the rainforests project. The colligation of facts and intrinsic values prompts the identification of fresh moral choices, and suggests new responsibilities for ecology that has now become 'the genesis of a science of man and nature' (di Castri, 1981).

About the time that Macleay and T. H. Huxley met in Sydney in the middle of last century, the world's population had reached its first billion. Nowadays it takes only 14 years to add another billion. Of the people who will be added to the world's population by the end of the century, about 90 per cent (about 1.5 billion) will be in the tropics, i.e. in the less developed, poor, third world countries of Asia, Africa, and Latin America. Already, in the third world, about 2 billion of the rural poor, in their struggle to survive, exhaust the soils, deplete the forests, destroy wildlife, and pollute the waters.

As the direct and indirect result of technological developments and the 'pullulating millions', the world's tropical and subtropical moist forests are disappearing at an accelerating rate. The rates of conversion vary from country to country, and among different land systems within a particular zone, so that average rates may be quite misleading. They have been heavily dramatized, with estimates varying from 20 to 40 hectares per minute (Myers, 1980). Unfortunately, most of the forests that have so far been cleared are the moister complex types with the greatest array of genetic resources at lower altitudes. Jacobs (1978a) illustrates this for Malaysia by noting that there are 9 different types of dipterocarp forest below 300 m, as opposed to 6 types between 300 and 700 m, and only 3 types between 700 m and 1200 m altitude. In the tropical humid region of North Queensland, this is more pronounced, as there are about 25 main structural types of rainforest below 800 m altitude but only about 8 main structural types in the 800-1600 m altitudinal zone. These facts indicate that proportionately more diversity is lost in converting lowland rainforest types.

Of the estimated 3 million species of plants and animals in the tropics, only about half-a-million have scientific names. It has been predicted that, at the present rate of destruction of the tropical and subtropical moist forests throughout the world, one-half to one million species of plants and animals will become extinct. Thus to retain as much natural or near-natural tropical forests as possible usually means 'conserving the unknown' (MAB Ecology in Action Exhibit, Paris, 1981). In stressing that less than half of the world's predicted threatened plants are known, we must realize that rare plants are no longer 'the playchild of a botanical elite'. In countries such as India, where there is so much reliance on the wild plant resource, plant conservation is an essential part of economic development (Synge, 1982).

Most people, especially biologists, would agree that species extinctions are a bad thing, although people's reasons vary. This is, however, a moral judgment. Since morals are the practice of ethics, and ethics is the science of morals, any opinion and action about species extinction must have ethical roots. Such judgment, which is freely made by biological scientists and some others, is therefore worth examining in a little more detail. The MAB Ecology in Action Exhibit in Paris (1981) claims that conserving both the known and the unknown is not just a question of altruism but of human survival, and proposes three justifications: 'to preserve the genetic information lost through species' extinctions; to keep open the options for facing our future requirements; and to conserve a natural diverse environment which will satisfy us morally and aesthetically'. This seems a fair proposition, and far from extremist. While acknowledging expediency and the necessities of practical life, it recognizes that less tangible values are of importance, and second to none.

There is thus a spectrum of ecological values for the conservation of nature, with pragmatism and self-interest at one end and the rights of nature apart from man at the other.

Myers (1978), while claiming that 'the problem of disappearing species could eventually be seen as one of the greater 'sleeper issues' of the late 20th century', neatly summarized the utilitarian reasons for conserving animal and plant genetic resources in tropical rainforests: for many particular uses in modern agriculture, in medicine and pharmaceutics, and in industrial processes.

At the other end of the continuum there are quasi-religious reasons for the conservation of so-called 'non-resources' (Ehrenfeld, 1976). Non-resources are species and biotic communities that do not have an economic value, or demonstrated potential value for use by man here and now. Some people try to justify non-resources to make them competitive with economic resources. For example, that recreational and aesthetic values are essential for mental health; species diversity and polycultures are less risky than monocultures; natural communities may provide clues to organization that ensures survival; certain species may be sensitive environmental impact indicators; natural ecosystems could serve as models for reconstructing degraded ones;

intact ecosystems are needed for teaching purposes. All these examples suffer from being too remote and nebulous to be convincing as political arguments. The ultimate justification is rarely articulated: a deep-seated fear that irreversible changes which reach a significant scale 'may carry a hidden and unknowable risk of serious damage to humans and their civilizations' (Ehrenfeld, 1976). Homocentric as this fear is, it is clearly impossible to assign resource values and priorities to non-resources that can rank with, and excel, the economic values of resources as treasured by a totally exploitative society. That neither development nor preservation can be total, however, gives grounds for believing that fresh value systems will continue to emerge.

Elton (1958) understood the spectrum of human attitudes towards co-existence with nature as a series of 'three absolute questions . . . waiting patiently to be answered' (which a quarter of a century later is still the case). He identified the questions as religious, aesthetic and intellectual, and practical. This is how he put the least scientific of these questions:

> 'The first, which is not usually put first, is really religious. There are some millions of people in the world who think that animals have a right to exist and to be left alone, or at any rate that they should not be persecuted or made extinct as a species. Some people will believe this even when it is quite dangerous to themselves'.

Examples of this belief are multiplying everywhere in the world. We witness them locally as campaigns and demonstrations in various rainforest areas in eastern Australia from north Queensland to south-west Tasmania.

In recent times, in October 1978, the tropical botanist Jacobs (1978b) taunted the 8th World Forestry Congress at Jakarta, the theme of which was 'Forests for People', by a paper quoting the contrary title: 'People for Forests'. Jacobs sensed a growing feeling in industrialized Europe that power over nature is no longer what it used to be, and predicted a change in forest policy towards mixed natural forests as well as, or in places instead of, monocultures. Jacobs argued that 'People for Forests' would have carried 'a more dignified appeal', and implied 'a notion of respect, and respect befits people'. He cited his colleague P. van Heynsbergen, an Amsterdam legal scholar, who went further, and published in 1977 a 'Declaration of the Rights of Animal and Plant Life' with eight paragraphs, the first of which reads that, in principle, 'Each living creature on earth has the right to exist, independent of its usefulness to humans'. This idea is echoed by the current Charter of Nature to be considered by the United Nations (Kamanda wa Kamanda, 1980).

These sentiments are no longer the eccentricities of a cultivated few in the so-called First World, nor are they restricted to philosophers, poets, oriental sects, and primitive Aboriginal society. It is worth considering Ashby's (1978) claim that the most effective defenders of nature today are not humanists, but scientists — mainly natural scientists aided by a few social scientists. To be effective — in a wider campaign — does require a certain scientific objectivity, because this is a basic prerequisite for communication by scientific workers who are not gifted like poets in this art, and because objective data can be tested by any other scientist. Scientific concern that nature be valued for its intrinsic worth reflects Elton's (1958) passion for conservation of the greatest possible ecological variety, as well as contemporary ecological intuitions about what interdependence in ecosystems and other holistic principles mean in the evolution of the human condition.

Somehow, despite the ingenuity of systems ecologists, and the synecologists' vision of 'emergent properties' at different levels of organization, holism as a working principle used by western scientists has done little to help solve the urgent problems of conservation and development in the developing countries of the tropics. Moreover, even in the most developed country of all, Odum (1977) noted that controversy had clouded the 'holistic strategy for ecosystem development', and suggested that the disappointing performance of the United States in the International Biological Programme could be attributed to lack of 'unifying themes or concepts'.

Yet a holistic frame of reference — the concept of environment in its totality, the habit of 'looking around corners', the prediction of inevitable effects in space and time of present actions — was being established slowly and firmly in widening sections of society by the ideas, whatever their media, of 'planet earth', 'the global village', and so on. Similarly but in a quite different context, spokesmen in the developing countries (e.g. Salim, 1982; Soemarwoto, 1982) were beginning to urge the use of traditional knowledge, and of holistic rather than analytical methods as a basis of ecological guidelines for development through conservation. Earlier ecological guidelines produced by the International Union for the Conservation of Nature and Natural Resources (Poore, 1976) had generally been applied from 'top to bottom' and had had little impact among the people.

Given this international and partly philosophical background, we can examine the values of the tropical rainforest resource to the Australian community. We should note that the definition of 'resource' is surprisingly wide, and includes computable wealth in materials; something in reserve; something to which one has recourse in difficulty; provision of relief or recovery and a means of spending leisure time. Passmore (1974) went much further with the definition of 'nature', teasing out its meanings in which man ranges from despot to primitivist, and noting its tangents with metaphysics and sentiment.

Throughout the four decades of my studies in CSIRO I have been exposed to an expanding spectrum of uses and 'non-uses' of rainforests for people. The facts of science — science that traditionally makes disinterested inventories of 'nature out there' — were only part of the spectrum. The spectrum was always being coloured, rainbow-like, through the prism of different values.

Always there were the covert and unacknowledged moral choices. But even more than this seems at stake. What of those people who believe, who somehow intuitively know, that ancient and prolonged existence in nature of Australian rainforest relicts has value? That it confers a right for these remnants to continue to exist as objects in nature? That this is now a new kind of 'justification' for not exterminating or damaging any more of them?

Let us examine some examples of the evolution of the less tangible values of rainforests that are not readily separated as scientific facts i.e. as evidence free from inference, opinion, and advocacy, and that are therefore bound to involve moral choices. This examination will require brief reference to some recent developments in tropical rainforest botany and ecology in Australia.

At the outset it should be acknowledged that any ecologist studying physical and biological processes in rainforests of the tropics and subtropics of the world cannot exclude human ecological processes from his chosen ecosystem. Often he cannot see the trees for the people; or in places like Peninsular Malaysia, for the extensive food and industrial monocultures into which nearly all the lowland rainforests have been converted. Food crops are needed for subsistence, if they can keep pace with exploding population. Industrial crops provide necessary income, although this may end up in foreign hands. Wholesale conversions of rainforest such as wood-chipping, e.g. in the Gogol Valley, Papua New Guinea, ignore ecological safeguards (Webb, 1977). Economic development becomes the manipulation of things, and any increases in human welfare 'are seen as being spin-offs from a rapidly growing economic system in which such things as income and consumption inequalities and natural resource destruction are considered normal' (De'Ath, 1982).

What are our historical perspectives as a nation about rainforests? Australia is the only developed country largely in the tropics. The area of rainforests throughout the whole of the continent when Europeans arrived was relatively small, about 1 per cent; plus another half per cent or so if coastal sclerophyll-rainforest mixtures, and scattered fragments in drier subcoastal north-eastern areas are added.

The rainforest area when Aboriginals arrived over 40,000 years ago was somewhat larger than when the first Europeans settled 200 years ago. The area was much larger during earlier moist warm interglacial periods. And long before man arrived, beyond the onset of arid conditions in the Plio-Pleistocene, and stretching back in time through the Tertiary to the Cretaceous and the origin of the flowering plants, rainforests (or moist closed forests) covered most if not all of the soils of the land mass that became Australia.

Current interpretations of the evolution of the rainforest and sclerophyll forest floras have reversed traditional botanical doctrine and the 'invasion theory' (Keast, 1981; Barlow, 1981). Previously it was thought that the sclerophylls were the most ancient, the only truly Australian (autochthonous) elements; whereas the rainforests were 'alien and invasive' immigrants. However, the sharing of many taxa by the tropical and subtropical rainforests in Australia and Indo-Malesia-Oceania is now construed as indicating common origins of palaeotropical stocks in Gondwanic times, as well as various migrations since (Webb and Tracey, 1981a; Webb, Tracey and Jessup, 1982).

Since European settlement, about two-thirds to three-quarters of the area of coastal and subcoastal rainforests and monsoon forests in the tropics and subtropics have been cleared, leaving about 10,000 km^2. Rainforest conversion has varied from virtually 100 per cent on the lowlands and tablelands of the tropical and subtropical coast, to virtually nil on high mountains.

We now view the last fragments of Australian rainforests through the eyes of fresh scientific understanding that is most conveniently dated from last year, which marked the publication of Keast (1981), and the first International Botanical Congress to be held in Australia. The rare and scattered distribution of the rainforests is the legacy of million-year-old climatic sifting, thousand-year-old Aboriginal burning, and century-old impacts of Europeans. Their rarity has now become valuable.

The network of refugia for distinct community-types, and the abundance of disjunct and different kinds of endemic plant species, are highly relevant to the location of reserves for nature conservation, especially for scientific purposes. This is one of the aims of the State National Parks and Wildlife Services, and a central aim of the UNESCO Biosphere Reserves and the World Conservation Strategy.

For Australian rainforests, 'small' may also be 'beautiful' (with an efficient buffer zone), so that a scattering of carefully selected smaller reserves — as well as larger ones — is essential to preserve not only within-species variation, but also relictual species and species-assemblages. There are virtually no data for minimum breeding population sizes for different categories of plants in Australian rainforests. Many tree species are restricted to very few sites (Tracey, 1981). These rare species are common where they occur. Are their population sizes stable? If the refugia are ancient, and the species are of low vagility, are the rare species tending to extinction in the absence of immigration? Australian rainforest distributions provide ready-made and natural experiments in island biogeography. Elsewhere, as in Amazonia, scattered remnants have to be preserved artificially for this purpose. The age, mutability, and diversity of refugia, and the endemic and primitive species in them, should all be considered in judgments about size, shape, and distribution of nature reserves (Webb and Tracey, 1981a; Kikkawa *et al.*, 1981).

The transitions and interspersions with eucalypts and other sclerophylls of the mostly closed, broad-leaved Australian rainforest and monsoon forest types that, unlike the sclerophylls, have many genera in common with Indo-Malesia, have ecological properties that are unique in the world. Boundaries in the tropics and subtropics are often abrupt, as the result of a combination of factors dominated by surface fire. Boundaries are generally gradual and extensive in temperate and montane regions where crown fires are a dominant factor, and in wet tropical and subtropical regions on poorer soils. The 'tall dark wall' of rainforest rising at the edge of the sunlit eucalypt grassy woodland — a metaphor beloved by some early authors — is actually only one of many types of transition. At least five types of transition of interspersion of the rainforest and sclerophyll forest floras can be recognized (Webb and Tracey, 1981b; Webb, Tracey and Williams, 1983). The evolutionary significance of the interspersed taxa, both phylogenetically and syngenetically, has not been studied in detail. The transitions and mixtures are nevertheless highly relevant to our understanding of community development and stability involving the rainforest and sclerophyll floras. It is certainly not helpful for this scientific purpose to discard or confuse ecological facts and hypotheses by pragmatic forestry typology based on commercial timber volumes. Commercial hardwoods such as Brush Box (*Tristania conferta*) reach relatively huge volumes in these transitional forests or 'mixed rainforests' at advanced stages of succession. Large Brush Box trees up to approximately 1200 years old were the subject of confrontations in the forest at Terania, and in court at Sydney, New South Wales, between forestry and the timber industry, and conservation groups (Prineas and Elenius, 1980). The conflicting values placed on these trees, either as logs or as ancient objects in nature, provide a classical example of the politics of ecology, and of the power of popular support for 'non-wood' values of Australian moist forests.

Ulterior factors have also entered the botany of Australian rainforests at the highest levels of vegetation classification. A comprehensive floristic analysis of Australian rainforests, either by tree species or tree genera, separates the subtropical formation-class at the third and fourth division respectively in the hierarchy (Webb and Tracey, 1981a, 1981b; Webb, Tracey and Williams, 1983). The subtropical rainforests, often characterized by Araucarian emergents that are of great antiquity and of high commercial value, should not, therefore, be regarded simply as impoverished versions of the tropical types farther north. The separate ecological identity of the subtropical rainforests has to be taken into account when judging the adequacy of existing rainforest reserves and national parks, especially when compared with those of the tropical and the montane types.

Species richness and the maintenance of diversity in natural and relatively undisturbed communities provides another example of the exercise of contrasting value judgements by ecologists and others. Given the fact that in complex rainforest communities, many species are represented by relatively few individuals in any one area, and remembering our ignorance of the numbers of individuals that constitute a survival threshold for a particular species, what changes in species can be predicted in a given area as the result of artificial disturbance, such as logging? Patchiness or clustering of organisms at different scales in space and time — so-called intrinsic and extrinsic diversity — is difficult to explain, and both stochastic and determinate processes seem to be involved (Webb *et al.*, 1972; Letouzey, 1978; Connell *et al.*, 1982).

Regeneration and succession have become ecological problems that have sprouted ideological roots. Several major types of succession have been described by different models, beginning with Egler (1954), and extending to Slatyer (1977) and Noble and Slatyer (1980). Alternative pathways and possible endpoints in reconstructive secondary succession of tropical and subtropical rainforest in north-eastern Australia were clearly explained by Hopkins (1981). These and other ecological studies show that regeneration and canopy development by secondary species in one rainforest type (e.g. simple notophyll vine forest characterized by Coachwood), are not comparable with another type (e.g. complex notophyll vine forest characterized by a mixture of species including Booyong).

Data from long-term monitoring of species over representative areas are not available as a basis for scientific judgment, which has wider terms of reference than forestry decisions about adequacy of canopy closure by secondary species, and where the restoration of an ecosystem similar to the original one controls the time scale since logging. Scientifically, the long-term advantages of conserving diversity in natural communities have been emphasized by many biologists with interests ranging from population dynamics (e.g. Elton, 1958; Connell, Tracey and Webb, 1982) to evolutionary genetics (Frankel, 1970).

So much for examples of ecological research which have harboured tacit value judgments and have involved intuitive reference to ecological precepts. We have also undertaken a project, with somewhat tenuous scientific links, to try to explicate, and thus to a limited extent communicate, our impressions as experienced ecologists of the rainforests. The attempt also has a practical basis: to determine criteria for selecting and managing national parks and similar conservation areas in northern Australia. Commercial values of material commodities, and protective values for soil and water are already accepted as of demonstrable economic worth. Attention is focused rather towards the other end — the cultural values — of the spectrum. The aim is to try to identify and objectify the values of tropical rainforest and associated forest and landscape for scientific, educational, recreational, and aesthetic purposes (Kikkawa, Webb and Tracey, 1974). A co-operative project with K. J. Polakowski, Landscape Architecture, University of Michigan, to determine aesthetic values is of special interest. It partly uses techniques for identifying relevant attributes at the macro-level of landscapes, by applying them to the micro-level of forestscapes. It describes perceptions of the rainforest environment in terms of ecological site factors, about which we have a great deal of quantitative information. The perceptions are then translated into a limited number of perceptual effects and emotional states, using various physical descriptors (vegetation structure, flora, fauna, sound, colour, light, etc.). The aesthetic experience of an (interested) observer is an interaction between his cultural and behavioural world and the intricacy and unfolding variety of the rainforest environment (Polakowski, Webb and Kikkawa, 1982). This experience is, from a synecological point of view, a kind of 'emergent property' (cf. Odum, 1977). The complexity and variability of natural ecosystems including humans cannot be captured even by the most sophisticated statistical methods. It can be argued that the sense of aesthetics in such situations is not a luxury, but a tool for survival. Aesthetic appeal may play a central role as a human judgment of the viability of ecosystems, and thus be somehow advantageous (Grossmann, 1982). Although it is appreciated that the identification of very broad categories of aesthetic experience must remain sketchy, the conceptual framework does bring together, in a very satisfying way, complex scientific and other values that were otherwise isolated. The framework should provide a stimulating approach to forest environments for children in schools, and for interested adults in the community. It could also be used as a guide to Aboriginal environmental perceptions that are part of the heritage of natural history.

Of wider ramifications geographically is our current attempt to match rainforest habitats in northern Australia and Indo-Malesian countries. This attempt is of theoretical and practical interest, and has social values. The aim of the project, partly funded by the UNESCO Man and the Biosphere (MAB) Project, is to use structural typology, supplemented by elementary environmental information and floristic data for common tree genera, to match forest types and habitats on a site-to-site basis. Given the ancient floristic links already noted between Australia and other south-east Asian countries, well-matched habitats with a high proportion of shared genera would suggest parallel evolution (homology) through common descent. Intuitive comparisons of forest types in the field during reciprocal visits of botanists to Thailand and Australia indicate a remarkable extent of shared genera in certain deciduous monsoonal types e.g. 66-90 per cent of Australian tree genera are shared with homologous habitats in Thailand. Evergreen lower montane forest types share fewer genera e.g. 33-55 per cent. Numerical analysis of the structural data is now being attempted, and will hopefully yield a more objective measure of comparison. Northern Australian rainforest and monsoon forest patches, although small and scattered, provide the only vegetation for structural and floristic comparison with other countries. This means that the sclerophylls, that have mostly displaced the rainforests and monsoon forests, and that have superior adaptations to fire, drought, and low soil fertility, provide a unique reservoir for plant introduction elsewhere, once comparable habitat-types are established by the systematic use of structural data. Besides enriching ecologic biogeographical understanding, the comparisons could contribute to agricultural and forestry practice. More than this, habitat-matching could help develop a 'common ecological language' based on the biotic communities of the region, despite their many man-imposed variations. Perhaps we should also say that tracing this ancient lineage of the Australian flora contributes, in the best tradition of natural history, to the enlargement of Australian cultural identity.

Although a common ecological language for the tropical region has yet to be written, there is no doubt in my mind that it will contain many cultural values and ethical overtones. I select only one recent scientific example, from the Man and the Biosphere (MAB) Workshop in Kuala Lumpur, January 1982. The speaker is the Director of the Forest Research Institute at Kepong, Peninsular Malaysia; and he is urging multi-species planting and the retention of adequately-sized blocks of natural forests in forestry areas:

> '. . . It is acknowledged that any of the above practices suggested could result in reduction of profits to the plantation owner. It is also true that the 'pest' population to the plantations could increase. However, it is our contention that sacrifice is necessary for the sake of our environment . . . To limit future generations to an environment of monotony is to limit their ultimate self-development. There is a moral obligation of society to provide the necessary environment to maintain the myriads of floral and fauna species of the world. Any loss and ultimate extinction of plant and animal life is a loss of human society' (Salleh and Hashim, 1982).

And so we return to where we began: to the meaning of values and their place in the ecological language that we all share in some way. Conventional ethics provide religious morality, and social morality and justice. These deal with man-man relationships. Is ecological morality and ecological justice now to be seen as a third-level development for man-nature relationships?

Thus the question about the intrinsic values of nature remains. I believe there are signs that this question may be considered safely at the level of science. Environmental values will continue to be 'good' or to be 'bad'. There seems no possibility of consensus, no definitive formulae, to decide how the protection of nature and the needs of modern society can be reconciled. But it is becoming increasingly clear that we must learn to live honestly with questions that will always remain open (Ashby, 1976). It seems wise to reject the concept of human domination, and to change the old ecological view from 'man the outsider' to 'man the insider' in ecosystems that involve nature (di Castri, 1981).

A re-assertion of ecological values cannot avoid involving feelings and sympathies (Wright, 1973). Ecological value systems by themselves are not enough. Ecological values are the results of valuing processes in relation to ecological principles (such as interdependence, diversity, continuity and change, the long-term versus the short-term, and so on). The separation of scientific research and problem-solving from valuing, all of which are in turn integrated in decision-making, is becoming increasingly questionable. It seems that novel and complex ecological situations must be matched by revised ethics if man and his culture, and if nature (which he needs, but which does not need him) are to survive.

We must find appropriate language, and appropriate values as part of it, for the description of complex ecological situations to be resolved by choice. These are the situations with tangled and seemingly incompatible strands: scientific values guided by the demands of objectivity, and ecological values grown indistinguishable from the responsibilities of care and preservation.

International forestry authorities are beginning to accept ethical responsibilities in forest management: for example, the recent statement by the President of the International Union of Forestry Research Organizations:

> 'The post-war generation of foresters has witnessed the most savage and fast destruction of forests in the entire history of man's work in the world. Quite often foresters are taking part in such destruction . . . Research has become a part of those economic concepts which aim towards exploitation . . . More than any other economic branch, forestry has been sat in the dock of the world, accused of destroying nature, for which it is only partly to be blamed . . . Research must be based on ethical principles of responsibility . . . Forestry and its research have to return to nature, which so far has not been done. Tomorrow will take man back to nature, because there is no other way' (Mlinsek, 1982).

What this forester, as a scientist, is asserting is that moral choices are inescapable in research as well as its applications. We must learn to recognize and acknowledge these choices. Such acknowledgment should not weaken our pursuit of objectivity, but make us better scientists as we become aware of more and more of the components of the ecological equation.

There are no simple solutions, but it seems clear that ethics and value judgments may no longer remain private affairs for individuals or bureaucracies that make decisions. Thus our values will evolve through the choices made. In other words, we will discover that the last vestiges of Australian rainforests are not so good to cut as they are 'good to think' (cf. Dwyer, 1982, p. 186).

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